



SPACE COMMUNICATIONS AND NAVIGATION

SmallSat Database

Dolores Petropulos

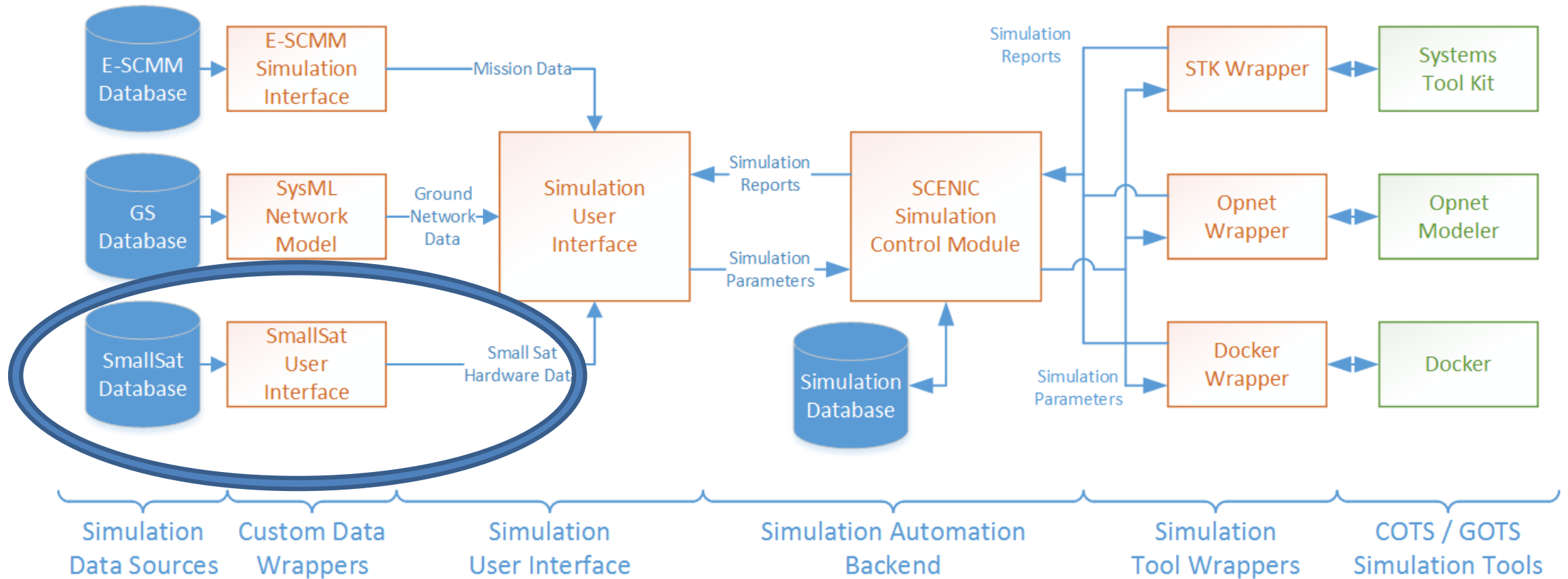
Mentors: David Bittner and Robert Murawski

SCENIC Project Manager: Bert Golden

Date: 06/28/15



Scenic Overview



My Project--SmallSat Relational Database



SmallSat Database



Dolores Petropulos



Rollins College
Winter Park Florida
Junior, Computer Science



SmallSat Database Research

Mentors: Robert Murawski and David Bittner

Subject Matter Expert: Tom Tanger

Research of Small Sat Hardware, development of database schema, and integration with future SCENIC Capabilities.

Task Activities

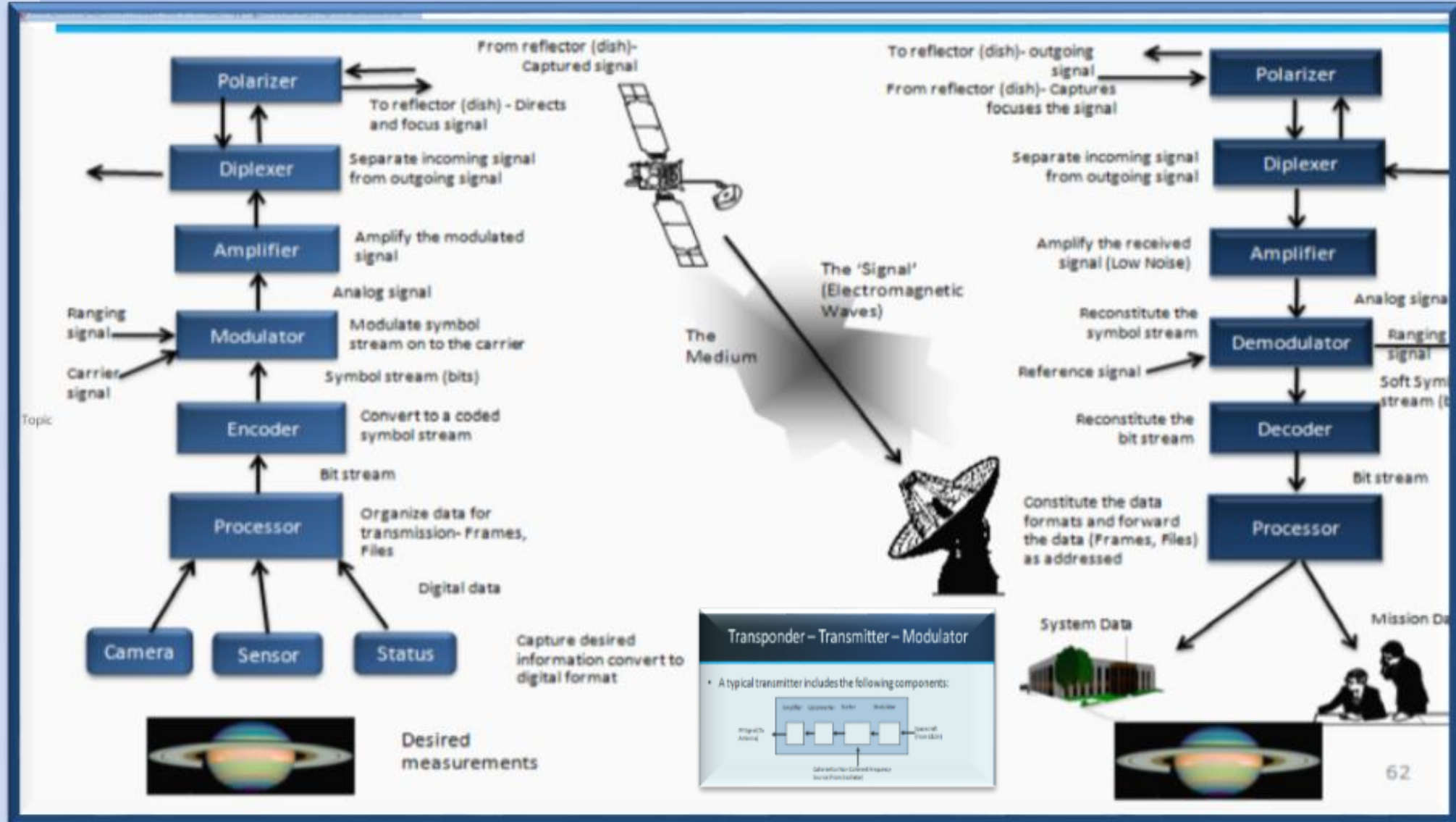
Week 1-3 SmallSat Research
Week 4-6 Database Development
Week 7-10 Refinement of Database Schema

Since miniature Satellite Technology is advancing quickly, there is a **need to create** an state of the art database and it's tools, which could cross reference small satellites and model them.

1. **Research** SmallSats
2. **Develop** a Schema to store smallSat data
3. **Work** with local subject matter experts to **refine** the database schema
4. Start **data gathering** on satellites



Important SmallSat Data





An Idea of Research Information



Board	TRL	Flight Heritage	Frequency Bands	Data Rate	Mass (g)	Output Power(watt)	Input Power (watt)	Volume (cm^3)	Modulation/FEC	Network Compatibility
Tethers Unlimited	TRL4	No	S-band-2450MHz	15 Mbps	380	1	~5	10X10X3.5	BPSK FEC can be added	NEN,TDRS,DSN
MHX-2420	TRL9	RAX	S-band	230 kbps downlink/ 76.8 kbps uplink	75	1 ???	~5 ???	8.9X5.3X1.8	FSK/FSK could be CDM	Partially NEN ???
AstroDev Lithium Radio	TRL9	RAX, Firefly, CSSWE, CXBN	UHF S-band (In Dev.)	9.6 kbps, 38.4 kbps, 76.8 kbps	52	250 mW – 4 W	~1.25-20	10X6.5X3.3	FSK/GMSK	None
	TRL9	DICE	UHF	24 Mbps downlink/ 250 kbps uplink	215	2	10	6.9X6.9X1.3	OPSK/FSK, GMSK Turbo FEC / Conv.	None
L3 Cadet	TRL4	No	S-band	???	???	???	???	???	???	\$200 K
	TRL4	No	S-band downlink/ UHF uplink	24 Mbps downlink/ 250 kbps uplink	215	2	10	6.9X6.9X1.3	OPSK/FSK, GMSK Turbo FEC / Conv.	None
Nimitz Radio	TRL3	No	S-band downlink/ UHF uplink	50 kbps/ 1 Mbps	500	1	~5	9X9.6X1.4	Uplink FSK, GFSK / Downlink BPSK	None
Marshall	TRL 7	FASTSat2	S/X-band downlink/ S-band Uplink	150 mbps/ 50kbps uplink	<1kg	2	~8	10.8X10.8 X7.6	BPSK/QPSK LDPC 7/8	NEN
Innoflight	TRL 9	Sense NanoSat	S-band/ X-band (In Dev.)	4.5 Mbps	300	2	~10	8.2X8.2X3.2	BPSK,QPSK, OQPSK, GMSK,FM/PCM Conv. and RS	NEN,TDRS,DSN
JPL	TRL ?	No	X-band	62.5 kbps/ 1kbps	400	4	~20	0.4 U	???	DSN



1. SmallSat Database: <http://www.smallsatdatabase.com/>
2. St. Louis Univ. Prof. Swartout database: <https://sites.google.com/a/slu.edu/swartout/home/cubesat-database>
3. Earth Observation Portal: <https://directory.eoportal.org/web/eoportal/home>
4. <https://directory.eoportal.org/web/eoportal/satellite-missions/>
5. Aerospace Small Satellite Cost Model database: <http://www.aerospace.org/expertise/technical-resources/small-satellite-cost-model/sscm-database/>
6. CEOS Database: <http://database.eohandbook.com/database/missiontable.aspx>
7. UCS Database: http://www.ucsusa.org/nuclear_weapons_and_global_security/solutions/space-weapons/ucs-satellite-database.html
8. Small Sats <http://www.kratostts.com/~media/kts/datasheets/satellite%20and%20space/a%20strategy%20for%20small%20satellite%20c2.pdf>
9. Small Spacecraft Technology State of the Art 2014.pdf
10. SSC12-VI-9 presentation.pdf
11. Klofas_table_Mar_2015.pdf
12. Example_radio_set.slsx
13. ATT00001.htm
14. ATT00002.htm
15. <http://database.eohandbook.com/database/missiontable.aspx>
16. http://www.ucsusa.org/nuclear_weapons_and_global_security/solutions/space-weapons/ucs-satellite-database.html#.VYGcn03bJaQ
17. <http://www.aerospace.org/expertise/civil-and-commercial/>
18. <https://directory.eoportal.org/web/eoportal/home>
19. <https://sites.google.com/a/slu.edu/swartout/home/cubesat-database#database>
20. <https://directory.eoportal.org/web/eoportal/satellite-missions/t>
21. <http://www.smallsatdatabase.com/database>
22. http://www.tethers.com/SpecSheets/Brochure_SWIFT_KTX.pdf
23. <http://www.microhardcorp.com/brochures/MHX2420.OEM.Brochure.Rev.3.1.pdf>
24. <http://database.eohandbook.com/database/instrumentsummary.aspx?instrumentID=1597>

plus Much More



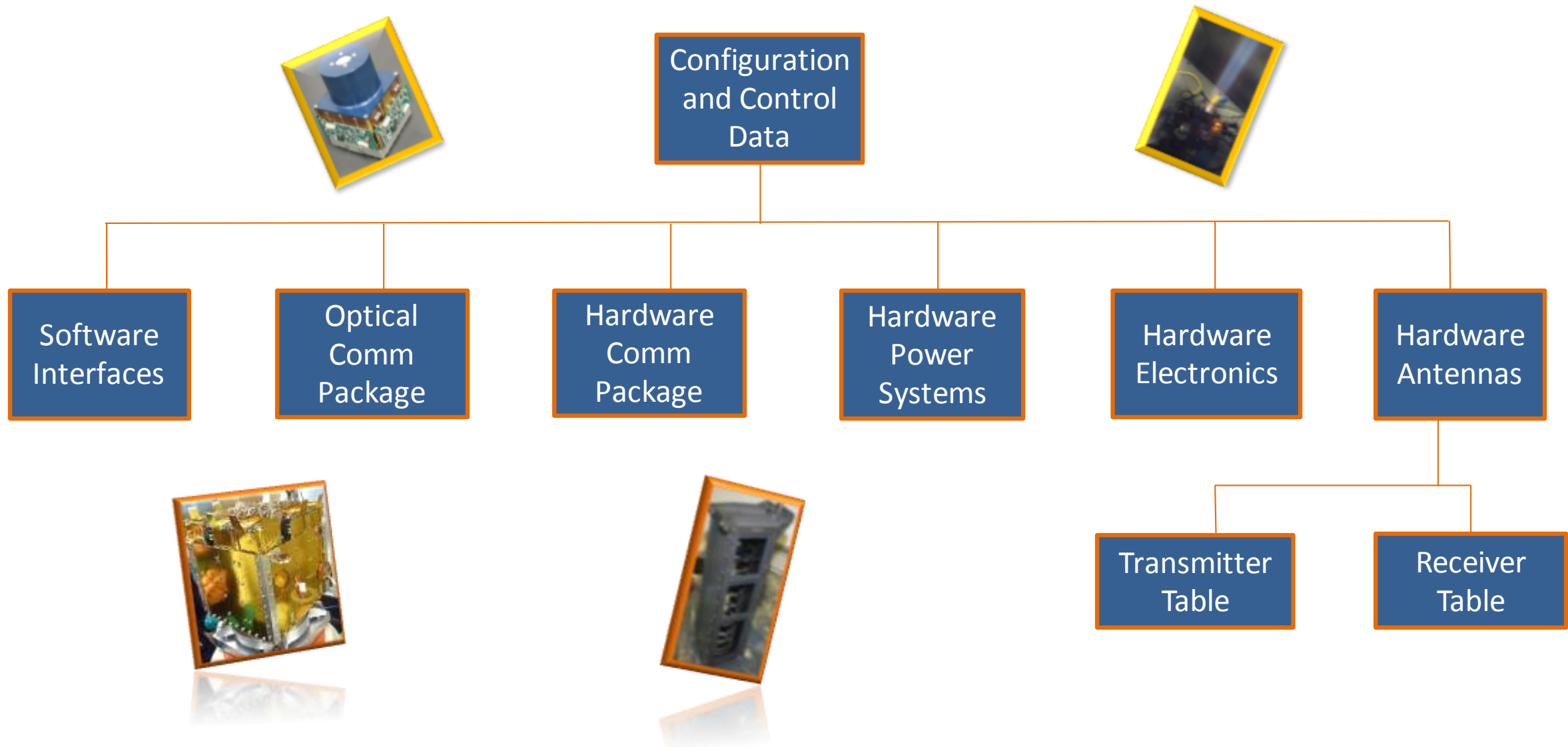
Small Sat Radio Catalog



SmallSat Radio Catalog					SmallSat Radio Catalog			
Transmitter	Missions Supplied	Quantity	Encoding	Number Antennas	Frequency	R Frequency Range	PPS Outputs	GPS
s-band downlink	ALSAT-1, UK-DMC-1, BILLSAT-1, NigeriaSat-1, TOPSAT, Beijing-1, CFESAT, GIOVE-A (ESA), Rapid Eye (xS), Deimos-1, UK-DMC-2, NigeriaSat-2, Nigeria Sat-X, Sapphire, exactView-1, KazEOSat-2 (2014), TechDemoSat-1(2014), DMC3	11	Convolutional	50 ohm antenna interface (SMA)	2.2 to 2.25 GHz < ±20 ppm 2.2 to 2.29 GHz < ±20 ppm	2.2 to 2.9 GHz < ±20 ppm	Up to 4 W RF power using 28 V unregulated supply, < 38 W	
Solar Array Drive Mechanisms transfer signals and grounding from the solar Array to the spacecraft, provides a continuous power transfer of solar array power to the spacecraft. (In Development.)	NovoSAR-5 (2015) DMC class mission (Launching 2016), 5 Third party Missions (Launching 2016-2020)	1	Convolutional	Multiple antennas (1-4) Supports up to 4 antennas for redundancy and advanced features e.g. Extra visible mode and altitude determination, etc.	Multiple frequencies (L1, L2C or L5/E5)		RS485, MLVDS (Option: TTL)	GNSS Receiver (SU/USP) 10/20, SGA Sensing
17 to 40 GHz K-band Tx and Rx frequency coverage in multiple sub-bands, Arbitrary waveform/modulation/coding	Unknown			1	Arbitrary waveform/modulation/coding			L3+K4+...
2.4 GHz Frequency Hopping Spread Spectrum Modem, which can be optimized for long distance communication over 30 miles (50km).	2012 (PWSAT)	1	On-board AX.25 command decoding	ISIS Antenna System Electrical Model (AntS_ELEC)	•Transmitter Frequency range: Single frequency in 130 - 160 MHz range (crystal controlled)	•Receiver Frequency range: 400 - 430 MHz range (crystal controlled)		flexible



SmallSat Database





The Small Satellite Database Project



Why Small Satellites:

Low priced, highly utilized for research and development

SmallSat Concerns:

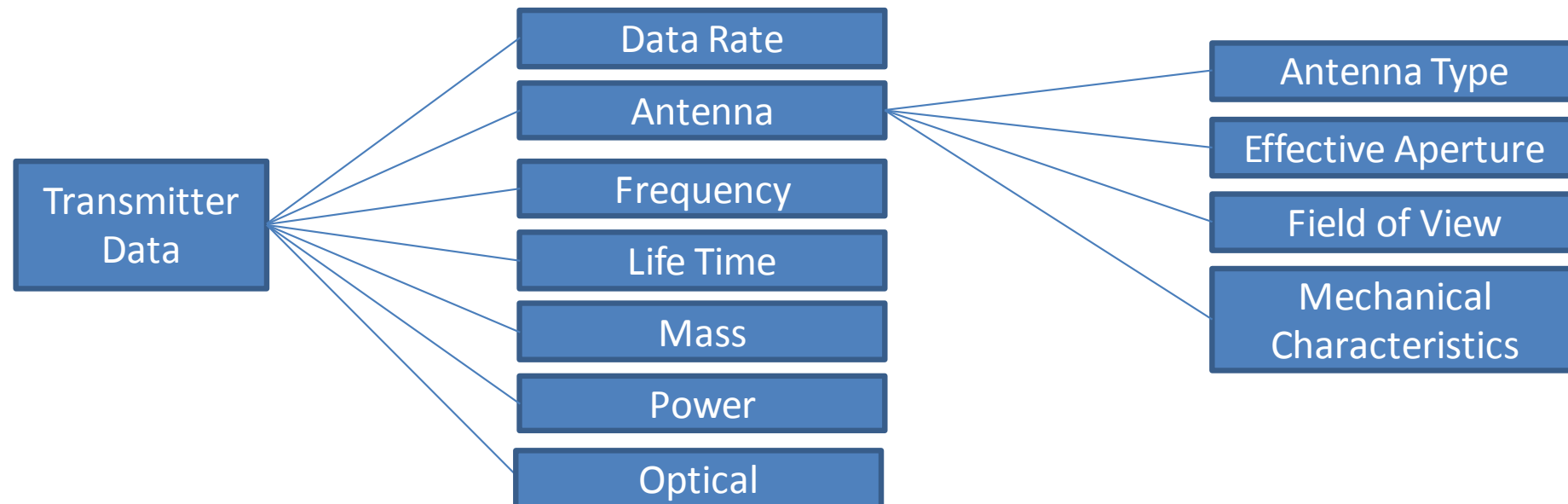
Could additional communication links stress current SCaN network capacity?

Small Satellite Information Required for SCENIC Modeling:

- ✓ What type of hardware is available for communication?
- ✓ What type of missions / how many missions are utilizing this hardware?

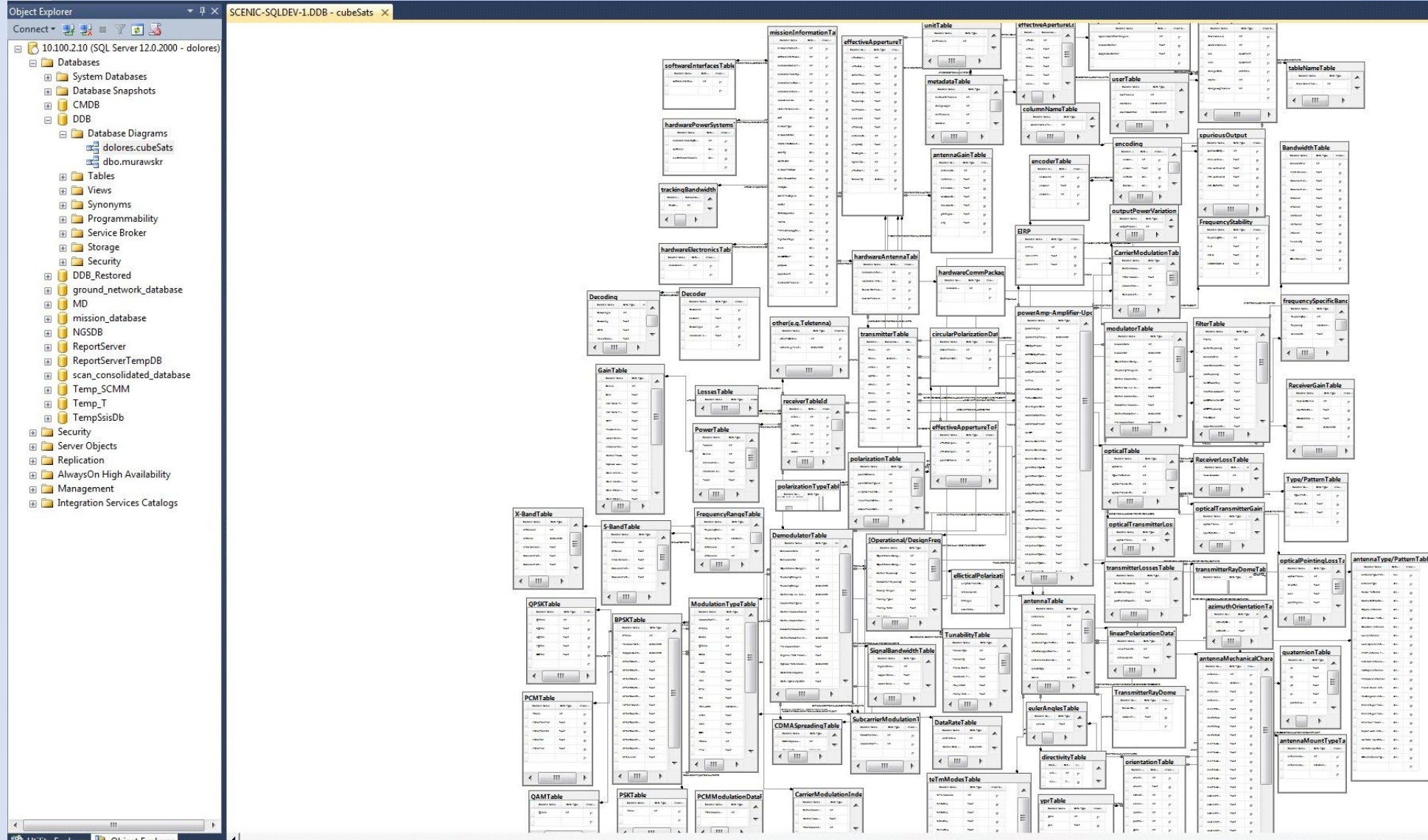
My Project: **Small Satellite Database Development**

Store all information required to model a small satellite communication link





SmallSat Tables

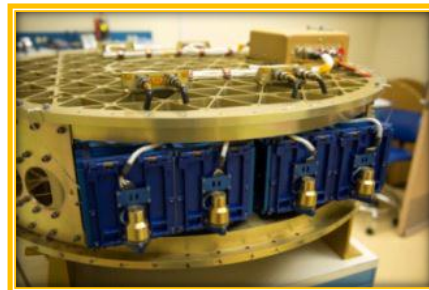




Approach



1. **Research** smallSats, their parts and their Companies
2. **Construct** a smallSat database which can cross reference all parts in the smallSat industry
3. **Future** Use...



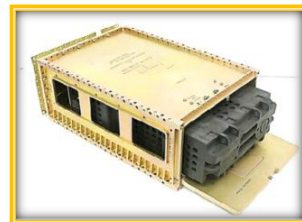


Future Use



Use it...

- ✓ To **Populate, verify and validate** smallSat Database
- ✓ To **Construct the tools** to attach it to the SCENIC system
- ✓ To **Integrate** the SCAN interns **SCENIC Simulation modeling system**
- ✓ To **keep up with smallSats** currently in orbit and in future orbit
- ✓ To **build and model smallSats** by their parts and systems
- ✓ To **Establish the costs** of a smallSat
- ✓ In a **similar way as the Enhanced SCMM Database** is being used in SCENIC, but for the smallSats.
- ✓ *And for....*

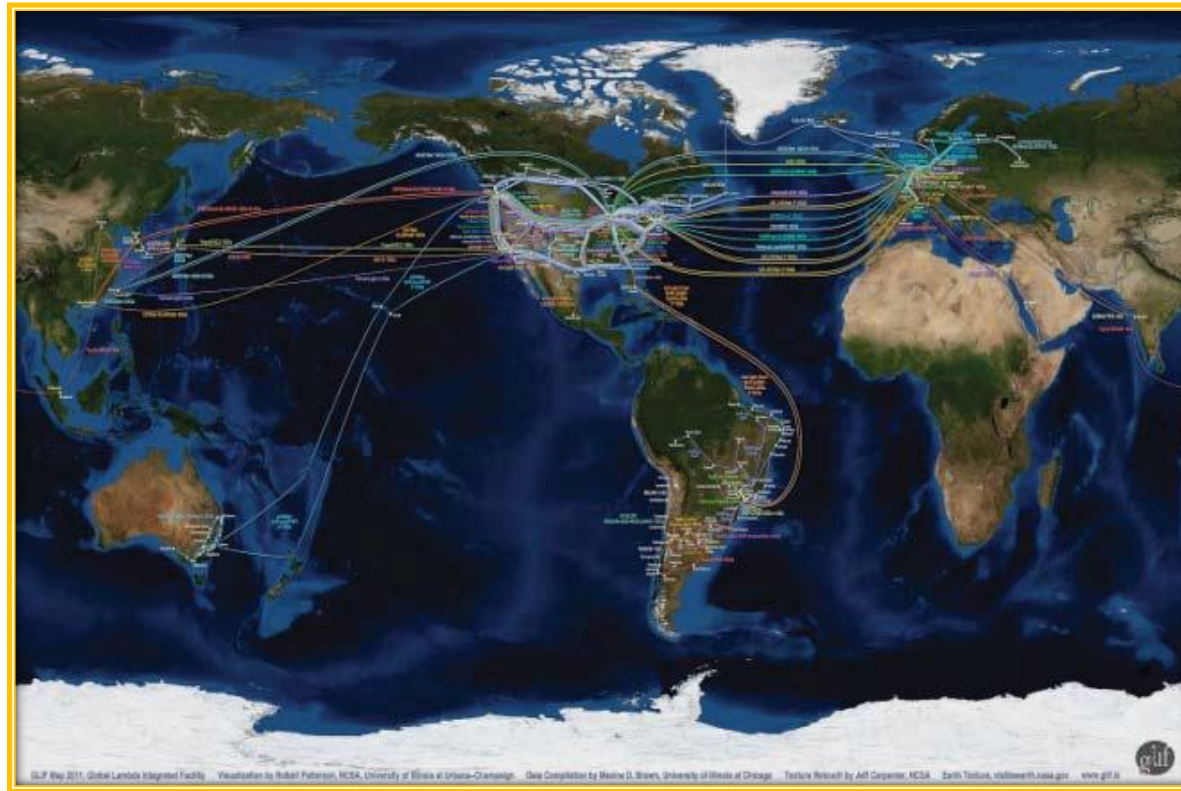




Possible Future Development



the SCENIC Emulation of SmallSats



The End